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STUDY REPORT
CAA-SR-88-34

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TRANSPORTATION IMPROVEMENT PROGRAM - MODELS (TRIPM)

FEBRUARY 1989

PREPARED BY
STRATEGY AND PLANS DIRECTORATE

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CAA

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This study was performed to assist the Headquarters, Department of the Army in identifying PC-based transportation models which could be used by action officers in conducting quick response analysis of the strategic implications of planning and programing requirements. The objectives of the study were to evaluate available PC-based transportation models to support quick response program analysis, recommend model modifications that would improve the models' usefulness in evaluating the impact of transportation resource changes, and train action officers in the use of the recommended models.

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February 1989

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DEPARTMENT OF THE ARMY
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REPLY TO
ATTENTION OF

CSCA-SP (5-5d)   11 SEP 1989

MEMORANDUM FOR Headquarters, Department of the Army, Deputy Chief of Staff for Logistics, ATTN: DALO-TSM, Wash, DC 20310-0562

SUBJECT: Transportation Improvement Program-Models (TRIP-M) Study

1. Reference letter, DALO-TSM, 1 Dec 86, subject: Army Strategic Mobility System Assessment (ASMSA).

2. The letter requested that the U.S. Army Concepts Analysis Agency (CAA) assess PC-based transportation models to determine their utility for use by action officers in conducting analysis of strategic mobility planning and programing requirements. This final report documents the results of our analysis. Included is an executive summary which provides an overview of the study.

3. I would like to express my appreciation to all the staff elements and agencies which have contributed to the study.

E. B. Vandiver

E. B. VANDIVER III
Director

Distribution statement A..
Per Major Robert G.Albrecht, Jr.
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CONCEPTS ANALYSIS AGENCY CAA UNITED STATES ARMY	**TRANSPORTATION IMPROVEMENT PROGRAM - MODELS (TRIPM)**	**STUDY SUMMARY CAA-SR-88-34**

THE REASON FOR PERFORMING THE STUDY was to assess available PC-based transportation models to determine their utility for use by Deputy Chief of Staff for Logistics (DCSLOG) action officers in conducting analysis of the Army's transportation program.

THE PRINCIPAL FINDINGS are that currently available transportation models (Airlift/Sealift, Force Closure Analysis Program (F-CAP), and Minotaur) which were reviewed are of limited use in their present form in the evaluation of transportation program changes; however,

(1) Limited program analysis can be conducted indirectly by translating funding changes to appropriate changes in model data affecting transportation assets and networks.

(2) If modified, the evaluated models have potential to become significantly more useful in program analysis.

(3) The evaluated models have potential for greater use in the area of operational planning and exercises.

THE MAIN ASSUMPTIONS are as follows:

(1) Suitable PC-based models exist which would lend themselves to use by DCSLOG action officers in analyzing the Army's transportation program.

(2) PC-based models identified as appropriate for DCSLOG action officers use can be converted to a mainframe version and transferred to the Headquarters, Department of Army (HQDA) Decision Support System (DSS) as elements of the Strategic Mobility Module.

THE PRINCIPAL LIMITATION of the study is that the feasibility and total cost of modifying the PC-based transportation models for mainframe use has not been addressed.

THE SCOPE OF THE STUDY is to review currently available PC-based transportation models.

THE STUDY OBJECTIVES are to: (1) evaluate PC-based transportation models to support quick response program analysis, (2) recommend model modifications that would improve the model's usefulness in evaluating the impact of transportation resource changes, and (3) train action officers in the use of recommended models.

THE BASIC APPROACH was to conduct research on the availability of PC-based transportation models. A list of candidate models was reviewed by the study sponsor, and six models were selected as final candidates to be evaluated in the study. The study team became familiar with the operation of each model and developed base case scenarios which were used to evaluate all the models. Each model was then evaluated against a set of qualitative criteria. When appropriate, modifications to the model were recommended. Finally, action officers were trained in use of the models.

THE STUDY SPONSOR was the Deputy Chief of Staff for Logistics, Headquarters, Department of the Army (HQDA), who established the objectives and monitored study activities.

THE STUDY EFFORT was directed by MAJ Robert G. Albrecht, Jr., Strategy and Plans Directorate.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-SP, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.

Tear-out copies of this synopsis are at back cover.

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TRANSPORTATION IMPROVEMENT PROGRAM - MODELS (TRIPM)

CHAPTER 1

EXECUTIVE SUMMARY

1-1. PROBLEM. In order to assist Headquarters, Department of the Army (HQDA) in developing an analytical capability to define strategic mobility requirements, capabilities, and shortfalls in the movement of Army programed forces and supplies through the transportation system, the Deputy Chief of Staff for Logistics (DCSLOG) has implemented a long-range plan for the development of a decision support system (DSS). Despite this effort, there is a void in the near term. Particularly needed is an improved capability in providing "quick turnaround" analysis to meet the DCSLOG planning and programing requirements.

1-2. BACKGROUND. In 1986, the US Army Concepts Analysis Agency (CAA) conducted a feasibility study for the Deputy Chief of Staff for Logistics. This study, Army Strategic Mobility System Assessment (ASMSA), defined the preliminary design and implementation strategy for a DSS. This strategy included the use of existing personal computer (PC) transportation models until such time that the DSS could be fully implemented. The use of the models would provide DCSLOG with a near term analytical capability to meet Office of the Deputy Chief of Staff for Logistics (ODCSLOG) planning and programing requirements.

1-3. PURPOSE AND OBJECTIVES

a. Purpose. The purpose of this study is to assess available PC-based transportation models for DCSLOG to determine their utility for use by action officers (AOs) in conducting transportation program analysis.

b. Objectives. The objectives of this study are to: (1) evaluate existing PC-based transportation models to support quick response analysis of program analysis of strategic mobility issues, (2) make recommended model modifications that would improve the model's usefulness in evaluating the impact of transportation resource changes, and (3) train action officers in the use of recommended models.

1-4. SCOPE AND LIMITATIONS

a. Scope. The scope of this study is to review currently available PC-based transportation models.

b. Limitations. The feasibility and cost of modifying the PC-based models has not been addressed as part of this study. Accordingly, the costs associated with modifying PC-based models prior to transfer to the DSS may not be cost effective.

1-5. TIMEFRAME. Current (1989).

1-6. ASSUMPTIONS

a. Suitable PC-based models exist which would lend themselves to use by DCSLOG action officers in analyzing the Army's transportation program.

b. PC-based models identified as appropriate for DCSLOG action officers' use can be converted to a mainframe version and transferred to the HQDA DSS as elements of the Strategic Mobility Module.

1-7. STUDY APPROACH AND METHODOLOGY. The basic approach was to review existing PC-based transportation models. A list of candidate models was prioritized by the study sponsor. This list of candidate models was further refined to six models which would be evaluated in the study. The study team next familiarized themselves in the operation of each model and developed a base case scenario against which the models were evaluated. Each model was then evaluated against a set of qualitative criteria. When appropriate, modifications to the model were recommended. Upon completion of the evaluation, action officers were trained in the use of recommended models. The following models were selected for evaluation and potential use by AOs:

- Minotaur (intertheater deployment model)
- Force Closure Analysis Program (F-CAP) (intertheater (air))
- Airlift/Sealift (intertheater)
- Intratheater Transportation Simulation (ITRANS) (intratheater)
- Mover (logistics over the shore (LOTS))
- Shaker (fixed port/LOTS)

1-8. SUMMARY OF FINDINGS AND OBSERVATIONS

a. The study directive contains four essential elements of analysis (EEA). These are listed below with a summary of conclusions on each.

(1) What are the transportation analytical requirements generated by program development increment packages (PDIP)? A PDIP is a presentation of the complete resource requirements associated with a major weapon system, commodity, or the proposed funding of a functionally-oriented issue. PDIPs are classified by functional panel. Each PDIP can be viewed with its own set of strategic mobility implications and analytical requirements. For the purpose of this study, analytical requirements have been defined in the form of questions which must be answered with quantitative rather than qualitative results. The basic analytical requirement, therefore, is the question: what effect does a PDIP and its level of funding have on the global transportation system? The following are quantitative measures of effectiveness (MOE) against which PDIP funding levels and changes may be compared.

(a) Deviation of required delivery date (RDD) from actual delivery date.

(b) Number of idle resources (lift assets) per unit of time.

(c) Percent utilization of lift assets.

(d) Average time in queue (waiting time) of lift assets.

(2) **What kind of transportation PDIP analysis and resource changes can PC-based models evaluate?** Existing PC-based models cannot currently make the necessary translation of a funding change to a model input (i.e., changes in movement requirements, network changes or capabilities). This task must normally be done offline by the AO. This task is normally subjective and somewhat difficult. The problem is translating dollar (funding levels) changes to changes in (capability) transportation resources (assets, movement requirements). Each model recommended for AO use was assessed on its ability to analyze funding and resource changes. The results are summarized in Table 1-1. Clearly, no existing model can perform an analysis of all types of PDIPs and funding changes. A combination of models may fulfill most analytic requirements.

Table 1-1. Evaluation of Transportation PDIP and Resource Change Analysis

Kinds of PDIPs	Airlift/ Sealift	Minotaur	F-CAP
Change in movement requirements	Yes	Yes	Yes
Unit readiness change	No	Limited	Limited
Network change	Limited	Yes	Limited
Transportation system management change	No	No	No
Increased capability	Yes	Yes	Yes

(3) **How can each PC-based model be used to evaluate the impact of each kind of transportation PDIP analysis and resource change?** Table 1-2 lists several examples of how the recommended PC-based models can be used in evaluating the impact of transportation related PDIPs and resource changes. The Airlift/Sealift Model is best suited for intertheater air and sea mobility analysis at a gross planning level (i.e., aggregated tonnage requirements). For analyses requiring greater detail the Minotaur and F-CAP simulation models are required. Minotaur is best used for quick analysis of regional or global strategic deployments. The model can simulate almost any deployment contingency within the limits of resolution of the transportation network and forces deployed. F-CAP is most appropriate for deployment analysis of division-level or smaller forces.

Table 1-2. Model Use in Evaluating the Impact of PDIP Analysis and Resource Changes

Model	Kinds of PDIPs	Method of model use
Minotaur	Movement rqmts change	Analyze deployment closure profile resulting from changes in RDD/ latest arrival date (LAD), avail dates, and new requirements
	Increased capability	Evaluate lift asset utilization and closure profiles resulting from changed characteristics and capabilities
F-CAP	Movement rqmts change	Evaluate unit closure times, estimate throughput requirements, and conduct aircraft tradeoff analysis by changing cargo/units deploying
	Unit readiness change	Changing equipment characteristics Changing availability factors of equipment
	Network change	Modifying nodes and links Changing cargo routing
	Increased capability	Modifying/building new capability Changing cargo routing
Airlift/ Sealift	Movement rqmts change	Evaluate deployment time estimates and number of aircraft required by changing cargo to deploy
	Increased capability	Adding/modifying lift asset characteristics

(4) What modifications must be made to the PC-based models to enable transportation action officers to use the models for program analysis? Table 1-3 contains the key modifications that can best enhance the models' usefulness for program analysis.

Table 1-3. Recommended Model Modifications

Model	Shortfall	Modification
Airlift/ Sealift	Simple weight methodology provides only gross estimates of aircraft closures and capacity	Aircraft capacity should reflect cargo density and aircraft cargo compartment
F-CAP	Based upon generic aircraft type - C-141 equivalent	Capability of simulation by individual aircraft types
	Data entry is time-intensive and must be done interactively	Capability to input data via files as well as interactively
	Lack of internal data base with aircraft cargo payload data	Add data base containing specific aircraft payload data from Army Force Planning Data and Assumptions (AFPDA)
Minotaur	Inability to simulate attrition of lift assets	Add an attrition algorithm
	Inability to simulate convoys	Add capability to form convoys as part of scenario data
	Inability to constrain transportation network	Ability to model port constraints as an input parameter
	Inability to capture lift asset utilization data	Capture and display lift asset utilization data for each vehicle in simulation
	Does not track cargo backlog at various nodes	Capture queue length data at each node

b. Key Findings. In their present form, the models evaluated are of limited use in the evaluation of transportation PDIP changes.

(1) No model was capable of directly evaluating the impact of funding changes; however, PDIP analysis can be conducted by translating the funding changes tc appropriate model data changes reflecting transportation networks, requirements, or assets.

(2) If modified, the models evaluated have the potential to become significantly more useful in PDIP analysis.

(3) All the evaluated models have use in the area of operational planning and exercises.

1-9. MODELS RECOMMENDED FOR USE. The Airlift/Sealift, Minotaur, and F-CAP Models are recommended for immediate use by DCSLOG action officers. Detailed evaluations and recommended modifications to these models are contained in separate chapters of this study. Mover is not recommended for use at this time due to the great difficulty encountered by the study team in getting the model to run without aborting in mid-simulation. The model developer was contacted to assist in getting the model to operate; however, despite corrections made to the model, it never ran well. Additionally, the model was never validated as part of the software development process. ITRANS ran well but was not recommended for use at this time. The model is useful for small problems but does not fit the scope of problems that need to be analyzed by DCSLOG action officers. Additionally, long setup time and the fact that all data must be entered interactively diminishes ITRANS' usefulness to AOs. Due to delays in model development, the Shaker Model was not available to the study team at the time of this writing.

1-10. CONTENTS OF THE REPORT. The chapters that follow, supported by the appendices, present the study results. Chapter 2 describes the methodology used in the study and evaluation of the PC-based models. Chapter 3 provides a brief overview of the candidate transportation models. Chapters 4, 5, and 6 describe in detail the evaluation of the models which were recommended for AO use. Appendix D describes the evaluation criteria that were used to evaluate the models. The final chapter summarizes the study, addresses the EEA, and provides the observations and findings based on the results.

CHAPTER 2

STUDY METHODOLOGY

2-1. INTRODUCTION. This chapter describes the study approach and methodology used by the study team in evaluating each PC-based model.

2-2. STUDY APPROACH AND METHODOLOGY

a. Approach. Figure 2-1 depicts the study approach. Initially, the study team conducted research to determine which PC-based transportation models were available. After an initial review of the candidate models, the sponsor and the study team agreed upon the models to be evaluated in detail. Next, a general evaluation methodology was defined. This general method of evaluation was tailored for each model and its individual characteristics. The specific deviations to the general method of evaluation are explained in the evaluations of the individual models. Formal model evaluation was conducted, action officer training was performed, and documentation was completed.

b. Methodology. Figure 2-2 depicts the process and methodology used to evaluate the models. The study team first became familiar with model documentation and ran the model with a default data set that was provided with the model. Next, a test case and real-world data set was developed for input into the individual model. A real-world application was chosen for two reasons: first, the study sponsor desired a set of inputs to run each model which could actually be used in analysis, and second, only a real-world data set could adequately stress the models. The development of input was the single most time-consuming step in the evaluation process. The data usually had to be constructed from hard copy sources, and in some cases had to be entered manually. The methodologies to get the data often required the writing of special purpose programs to extract and manipulate data from automated data files. The model was then rerun with the test case data, and sensitivity analysis of the output was conducted. The formal evaluation was then conducted against a standard set of criteria. Specific evaluation criteria are contained in Appendix D. Where appropriate, recommended modifications for each model were made and documented. These recommended modifications can serve as a basis of making the models more useful to action officers in conducting program analysis. Finally, action officer training was conducted in the use of each recommended model.

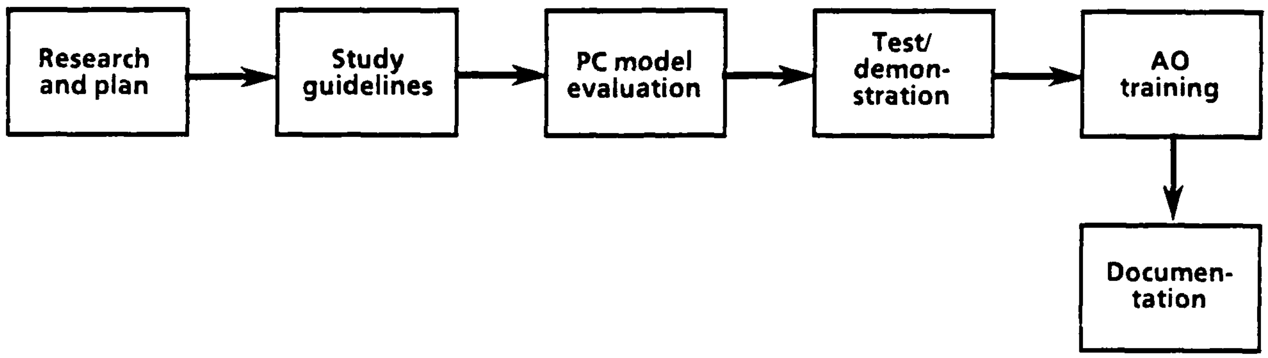

Figure 2-1. Study Approach

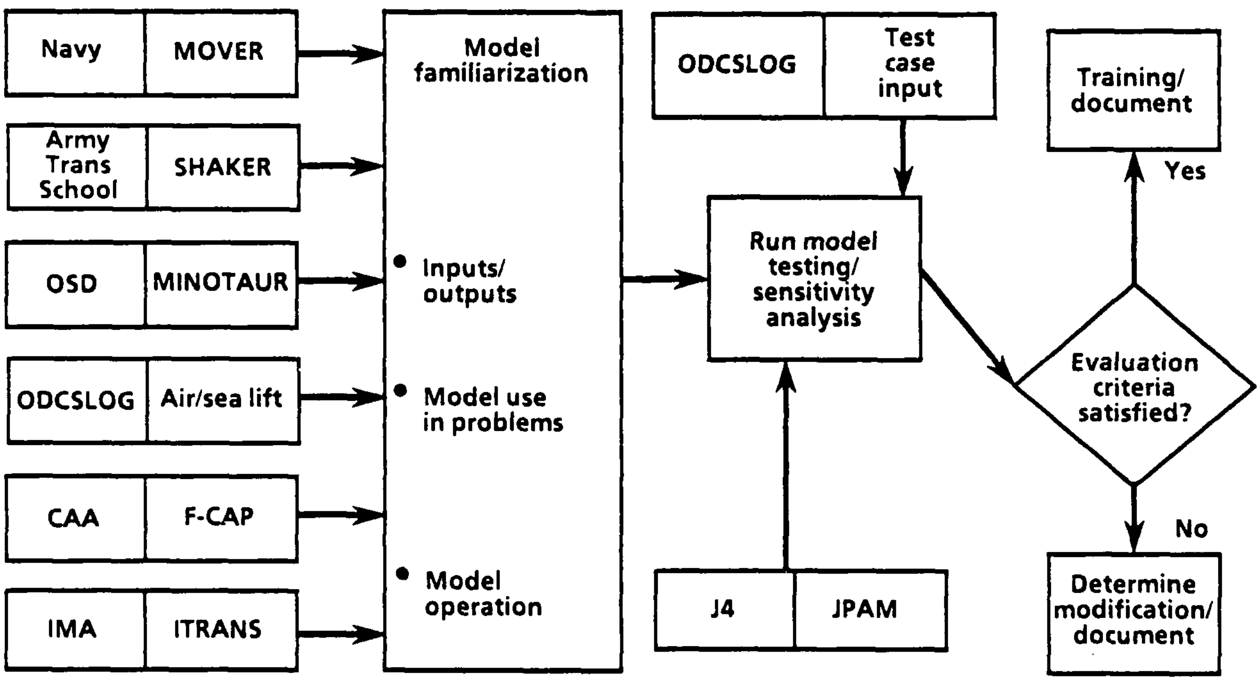

Figure 2-2. Model Evaluation Methodology

2-3. MODEL FAMILIARIZATION. In order to become facile in the use of each model, the study team initially spent time reading all available documentation. In most cases, the model documentation was satisfactory. Most of the models contained a default data base set that could be used for model familiarization purposes. These data bases were used in order to learn how to operate each model. When problems arose that could not be answered by documentation, the model developer was contacted and asked to provide possible solutions. In most instances, the model developer assisted in solving the perceived problems. Once familiar with the models' operation, a model test case was developed for use in the evaluation process.

2-4. BASE CASE DEVELOPMENT. In order to develop base cases for each model, a real-world problem and set of data was obtained. The actual cases used are explained in detail in the individual chapters pertaining to the model evaluation. This data set was then run through the model and output was analyzed. In most cases, this output was compared to similar output from a model which, on the surface, seemed reasonable to people knowledgeable about the problem under study. The primary model used for comparison purposes was the CAA intertheater Transportation Model (TRANSMO).

2-5. MODEL EVALUATION

a. Evaluation of Program Development Increment Packages (PDIPs). Each model was evaluated in terms of its capability to help in analyzing the impact of PDIPs and resource changes. The PDIP is a presentation of the total resource requirements associated with a major weapon system, commodity, or the proposed funding of a functionally-oriented issue. The PDIP introduces information in the Department of the Army (DA) decisionmaking process, linking resource requirements to functional issues that contribute to the total Army mission. A PDIP identifies the capability that is recommended for resourcing, why that capability should be resourced, and how much, in terms of dollars and manpower, the capability will cost in each of the 5 years. Each model was evaluated on its capability to define and defend, in an analytical and objective way, strategic mobility PDIPs.

b. Evaluation Criteria. The following major evaluation categories were established. Detailed criteria associated with these categories are in Appendix D.

(1) Applicability - how well does the model fit the problem or situation to be analyzed?

(2) Quality - how good is the model analytically?

(3) Ease of use - is the model easy to use and does it produce useful outputs?

2-6. ACTION OFFICER TRAINING. Training was provided to action officers in the use of each of the recommended models. A model overview and general methodology was provided. Model assumptions and limitations were discussed, and copies of all available documentation pertaining to the model were provided to the sponsor. Action officers were shown how to build files, create and edit data, and build a sample problem to run in the model. A practical exercise was also conducted for each model. The sponsor developed the problem and described the scenario which served as the basis for the practical exercise.

CHAPTER 3

OVERVIEW OF PC-BASED TRANSPORTATION MODELS

3-1. INTRODUCTION. A wide range of PC-based transportation models has been developed for Department of Defense (DOD) agencies and the services. These models were normally developed to model specific aspects of the transportation system and unique needs of the agencies that initiated model development. These models vary from very detailed resolution of small systems such as logistics over the shore (LOTS) or fixed port operations to global deployment models.

3-2. CANDIDATE MODELS. After conducting a search of available transportation models, a list of potential candidate models was chosen by the sponsor for evaluation. Table 3-1 lists the models selected for evaluation.

Table 3-1. Candidate Models for Action Officer Use

Model	Purpose
Airlift/Sealift	Intertheater
Mover	LOTS (requirements)
Shaker	LOTS/fixed port (capabilities)
Minotaur	Intertheater
F-CAP	Intertheater (air)
ITRANS	Intratheater

3-3. MODEL OVERVIEW

a. Airlift/Sealift. The Airlift/Sealift Model is a formula-based model used to compute intertheater air and sealift capabilities and requirements. The model is written in dBase III+ and was developed by CAA from a LOTUS 1-2-3 spreadsheet program used by a DCSLOG action officer. Model inputs include: type and quantities of lift assets, origin to destination distances, cargo requirements, and lift capacities. The model output includes the number of days required to deploy by air or sea, given available lift assets and the quantity of cargo specified for movement. The model is capable of computing the number of lift assets required to move a user-specified quantity of cargo within a specified number of deployment days.

b. Mover. The Mover Model is a deterministic simulation model that calculates equipment and personnel requirements for LOTS operations. Mover is written in BASIC and is capable of simulating one LOTS site per simulation. The model was developed by Information Spectrum, Inc. Mover inputs include an arrival profile of ships by days and cargo type. Outputs

include required personnel and equipment to offload the profile of arriving ships, offload schedule by day and cargo type, and inland movement requirements. The model is packaged on a single floppy disk which includes default data files for training and familiarization.

c. **Shaker.** Shaker is a deterministic simulation model being developed by Information Spectrum, Inc. that calculates throughput capabilities and shortfalls for both LOTS and fixed port operations. Shaker is written in Simulation Language for Alternative Modeling (SLAM) and simulates cargo reception, discharge and transfer, and clearance operations. The model is capable of simulating one fixed port area, two separate LOTS sites, and five inland marshalling areas. Model inputs include a ship arrival profile, port profile data, ship characteristic data, weather data, and terminal service equipment and personnel data. The model provides the user with several levels of output reports. These include summary tonnage and activity reports, utilization statistics, and detailed activity reports.

d. **Minotaur.** The Minotaur Model is an intertheater strategic deployment simulation model and data management system developed by General Research Corporation. The model is written in Turbo Pascal and is intended for use in instances where a highly aggregated and simplified representation of a deployment is needed. Model inputs include scenario data, transportation asset availability and capability data, network data, and movement requirements data. Model output includes an individual movement schedule and closure summary.

e. **F-CAP.** The Force Closure Analysis Program (F-CAP) was developed by CAA for the XVIII Airborne Corps, G3 Plans, to automate and improve their existing methodology for computing force closure by air. F-CAP consists of two programs, the Force Closure Simulation (FCS), and the Lift Asset Estimator (LAE). FCS determines unit closures by simulating departure and arrivals by air movement. LAE can be used to determine the number of aircraft sorties required to move specific units. FCS is written in Turbo Pascal and LAE in BASIC. Model inputs include aircraft and aerial port characteristics and capacity data and movement requirement data. FCS output includes aircraft departure and arrival times and unit closure times for both airland and airdrop operations. LAE output includes the minimum number of aircraft required for 1- to 10-day closures, average number of sorties per aircraft, estimated POD throughput requirements, and aircraft tradeoff relationships.

f. **ITRANS.** Intratheater Transportation Simulation (ITRANS) is a deterministic intratheater simulation model developed by Interactive Microcomputer Applications, Inc. The model simulates multimodal (highway, air, rail, inland waterway, and pipeline) transportation over a user-defined transportation network. Model inputs include network data, lift asset characteristics and capacities, and movement requirement data. The model can simulate scenarios up to 60 days in length. Model output is in the form of a delivery report which details cargo arrivals by time period and destination. All data is entered interactively within the model. ITRANS can model networks with up to 99 links for each mode of transport.

CHAPTER 4

AIRLIFT/SEALIFT MODEL

4-1. INTRODUCTION. This chapter describes the Airlift/Sealift Model and the development of the data bases to support it, details the model evaluation, and provides conclusions and recommendations for model improvements.

4-2. MODEL DESCRIPTION

a. The Airlift/Sealift Model is a straightforward, computational model which uses dBASE III+. The model originally existed as a LOTUS 1-2-3 spreadsheet designed and used by a DCSLOG action officer (DALO-TSM). The sponsor desired that the spreadsheet be made more user-friendly by designing the same functions into a dBASE III+ program. This project, completed as part of the TRIPM study effort, performs exactly the same tasks in the same manner as the spreadsheet, with the exception that the user is prompted for data entry and menu choices from screens as opposed to manipulating a spreadsheet.

b. The model is a low-resolution transportation model which can be used by action officers to compute transportation airlift and sealift requirements necessary to deploy a specified amount of cargo over a given distance and timeframe. The model can also be used to determine the number of days required to deploy cargo over a given distance for each specified type of airlift or sealift asset. The user assigns cargo to an aircraft or ship type, and the model acts either in a requirements or capabilities mode. The model will output the number of lift vehicles required or the number of days needed to deploy the assigned cargo, given the number of lift vehicles available (capability mode). Movement requirement inputs consist of the number of tons of cargo or number of passengers to move over a specified distance in miles. The user may also change the characteristics of each lift asset type (speeds, utilization rates, average payload, load times, theater/continental United States (CONUS) movement time) or use standard factors. There are two separate versions included in the model--one for airlift and one for sealift. The user explicitly assigns cargo to lift vehicle types within each version--there is no linkage between the air and sea modes. The model is not a simulation, nor does it optimize or contain any random processes. Instead, the model uses mathematical formulas relating distance, rate of speed, time, cargo capacity, and other rates to compute output. In essence, the program operates by making gross estimates of lift requirements by using the "weight method" for airlift estimates and a similar computational technique for sealift.

4-3. BASE CASE DEVELOPMENT. The evaluation of the model was accomplished with the default data contained within the model's data base. This data base was developed from data contained in Air Force Pamphlet 76-2, Airlift Planning Factors, Military Traffic Management Command (MTMC) Pamphlet 700-1, Logistics Handbook for Strategic Mobility Planning, and Chapter 7, Army Force Planning Data and Assumptions (AFPDA). The sponsor provided a real-world scenario and problem that could be run using the model. This scenario became the model base case. The problem consisted of determining the closure time for the deployment of two brigade-size elements of the 82d Airborne Division

and 9th Infantry Division from CONUS to Southwest Asia by air and sea. The number and type of aircraft and ocean vessels were given as constant values. The actual movement requirements were expressed as bulk, oversize, and outsize tonnage. Other strategic planning factors not provided by the sponsor or contained within the model's data base were obtained from the above-mentioned references and were used as input to the model. The model results were identical with those produced by the sponsor using the spreadsheet version of the model.

4-4. EVALUATION

a. Applicability. The model can adequately provide gross estimates for air and sea deployments of the intertheater transportation system. The model may also be used to evaluate intratheater airlift requirements and capabilities. It requires a very short amount of time to set up the model. An analytical task should take no more than 30 minutes to complete. Model outputs are practically instantaneous. The only computer skills required to operate the model are a rudimentary knowledge of MS-DOS and the ability to follow the selections and instructions presented by the menu-driven screens. The model cannot directly analyze the impact of changes in funding levels of PDIPs; however, the model can be of use in assessing the consequences of alternative deployment scenarios by providing rough estimates of the number of assets required or amount of time required to deploy a given force. As an example, the model can evaluate PDIPs affecting movement requirements, additional or upgraded lift assets (e.g., C-17 aircraft and ultra-fast surface ship (UFSS)), or changes in capabilities of current lift assets (e.g., improved loading/unloading efficiencies or cargo capacities). A comparison of deployment time estimates and numbers of required lift assets can be accomplished with the model output.

b. Quality

(1) The model provides a rough estimate in determining the true requirements of the transportation system, since the model uses what is known as the "weight method" of calculation. This is an accepted methodology valid for gross planning requirements. This method, however, ignores three constraints on aircraft load capacity--the bulk (dimensions) of individual unit equipment to be loaded, the cargo compartment dimensions, and the structural characteristics of the aircraft. Additionally, many factors must be considered to make precise computations of airlift capability. It is impractical for a model of this nature to consider all the impacts of these factors. Only the most critical factors are included as part of the model, but lack of consideration of other factors limits the model's precision. The degree to which the precision is limited is a function of the specific case under consideration.

(2) The model's methodology is a simple and straightforward arithmetic calculation based upon user inputs. This amounts to dividing the total weight of personnel, equipment, and vehicles by the allowable cargo load in order to determine the number of aircraft needed to lift the unit. A similar method is used in determining sealift requirements.

(3) The following are the assumptions used in the Airlift/Sealift Model.

(a) Cargo assigned to a lift asset is compatible with that asset. For example, assigning a given unit and its weight to an aircraft type may be doctrinally incorrect because of the actual composition of unit equipment. An armored battalion simply cannot be loaded onto C-123 aircraft if it has M60-series main battle tanks. Accordingly, the user must exercise extreme caution in assigning cargo to lift assets.

(b) Total weight of cargo is the driving force in determining lift requirements. This assumption can have a significant impact because in lighter units, floor space is often the driver. For example, in an airborne unit, the floor space of an aircraft will be completely used by several small, wheeled utility vehicles, while using only about 20 percent of the aircraft's weight capacity. Other type units may have equipment which fills the volume of the lift asset before weight or floor space constraints are exceeded.

(c) Onload and offload times are assumed to be fixed over time for sealift and are not explicitly assigned to airlift.

(d) Utilization and productivity rates are assumed to be fixed over time.

(e) There are assumed to be no port constraints. The user must handle port constraints outside of the model.

(f) Weather and attrition are not considered.

c. **Ease of Use.** The model is menu-driven and easy to use. Data is readily available to the AO. Data on lift assets are available in common United States Air Force (USAF) and Army publications (speeds, payloads, etc.). Movement requirement data, however, must be modified to fit the model. For example, the model requires cargo be specified in terms of short tons, and available data are given in various units of measure: measurement tons, short tons, square feet, and number of containers. All of these units of measure must be converted and explicitly assigned to a lift type as input to the model.

4-5. CONCLUSIONS. The Airlift/Sealift Model is somewhat limited due to the methodology used. Even if the model were modified as recommended below, its utility in program analysis would still be minimal. This is due to the fact that the weight method itself is intended only for very gross estimates. Notwithstanding, the model is recommended for action officer use. The model has obvious utility in conducting deployment scenarios in exercises to obtain gross closure estimates. Additionally, it may be helpful in training action officers in providing an intuitive feel for deployment activities and weight method of determining lift requirements.

4-6. RECOMMENDED MODEL ENHANCEMENTS. Discussion concerning recommended modifications is restricted to retaining the weight method as the methodology of the model. Changing the model's internal methodology would be akin to rewriting the model and is not recommended. Some of the modifications which would fully enhance the weight methodology are noted below.

a. The model should take a single gross movement requirement representing a deployment and be able to assign cargo to lift assets internally. The assignment of cargo should be based on sound rules already used by planners. Currently, the user explicitly assigns cargo to individual lift asset types.

b. The model should assign proportional quantities of weight to bulk, oversize, and outsize capable aircraft based upon unit types. For example, an armored unit has more oversize equipment than a light infantry unit.

c. The sealift version of the model should be capable of computing lift asset round trips in determining requirements and days to deploy. This capability exists in the airlift version of the model but not in the sealift version.

CHAPTER 5

FORCE CLOSURE ANALYSIS PROGRAM (F-CAP)

5-1. INTRODUCTION. This chapter describes the Force Closure Analysis Program (F-CAP), provides an evaluation of its capabilities, and provides recommendations for model improvements.

5-2. MODEL DESCRIPTION. F-CAP is a software package designed in response to an XVIII Airborne Corps requirement for a quick turnaround estimator for force closures to an area of operations. F-CAP consists of two programs, the LAE and FCS. LAE is used to compute, for a given unit or package movement requirement, the number of C-141 equivalent aircraft required to move the package. LAE also provides a tradeoff table for calculating combinations of lift assets (e.g., number of C-130 and C-141 or number of C-5 and C-141) needed to move the package in 1 to 10 days to a destination. A primary purpose of LAE is to provide data required to input FCS. FCS simulates the movement of C-141 aircraft from port of debarkation (POD) to port of embarkation (POE) and provides as output a table summarizing the movements. FCS uses C-141 equivalent aircraft only; hence the need to use LAE to calculate this number. FCS has the capability to model operational constraints of the PODs and POEs. Up to five PODs and five POEs can be modeled.

a. Force Closure Simulation. FCS is designed to give a quick estimate of the time required to deploy a unit, considering the following factors:

- Number of POEs.
- Number of PODs.
- Maximum number of aircraft missions on the ground (MOGs) for each airport.
- Load/unload time per C-141 equivalent aircraft at each airport.
- Operational hours of each airport.
- Number of aircraft available for use.
- Airspeed of aircraft.
- Representative distance between POEs and PODs.
- Aircraft utilization rate.
- Hour of the day to start the operation.

FCS allows the flexibility to aggregate or disaggregate units into packages of variable sizes to allow resolution at various levels (e.g., a division-size unit may be broken into battalion packages in order to determine when each battalion will close). For each package, a port of embarkation. port of debarkation, package name, method of delivery (airdrop or airland), and

number of aircraft sorties required to move the package is specified. These packages are grouped together in a data file which lists packages in priority order. The package to be delivered first is at the top of the data file, the package to be delivered second is next, etc. The program attempts to deliver the packages in this order first, but will deviate from this priority in an attempt to better utilize airlift assets based on the constraints present. The program provides a listing which shows when each aircraft sortie closed, the times airports opened and closed each day, the times when no aircraft were available for use, and the time an entire unit (set of packages comprising the unit) closed.

b. Lift Asset Estimator. LAE is designed to calculate the number of C-5, C-130 and C-141 aircraft needed to move a unit's cargo and passengers to a destination. It also computes the relationships between types of aircraft, allowing rapid tradeoffs to be made between aircraft types with minimal offline work. The LAE program was designed for two specific purposes. First, it can be used as a quick planning tool for determining the appropriate numbers and types of aircraft needed to move a unit a given distance in a specific time. The second purpose for LAE is to serve as a preprocessor program to the FCS program. FCS requires user input of the total number of sorties needed to move a unit. For example, an FCS user must know that a specified infantry company, supported by an antitank section, can physically be loaded on 2.5 C-141 aircraft. LAE provides any user a methodology for estimating the required aircraft and therefore the capability to use both programs of F-CAP.

5-3. BASE CASE DEVELOPMENT. In order to evaluate F-CAP, a base case was developed using data from the OMNIBUS-89 Deployment Analysis conducted by CAA. The OMNIBUS Study assesses the capability of current US Army forces to mobilize, deploy, fight and sustain military operations in the Defense Guidance Illustrative Planning Scenario (DG IPS). The deployment analysis portion of OMNIBUS is conducted using the CAA TRANSMO. The TRANSMO inputs and parameters used to deploy 31 packages from CONUS to Korea were used as the base case inputs and scenario. LAE was used to produce sortie requirements, and FCS simulated the use of these sorties to deploy the packages. The results of the FCS simulation were compared to TRANSMO deployment results for these packages. The closure time provided by TRANSMO for these packages was 10 days, 4 hours; the closure time produced by F-CAP, 10 days, 2 hours.

5-4. EVALUATION

a. Applicability. The F-CAP models can be set up to run in several minutes if the user has the required input data onhand. FCS input is partly in the form of an ASCII input file, constructed using a word processor or line editor. Given the availability of input data, a file can be constructed in a few minutes per movement requirement. However, unless the user has a preconstructed library of units in FCS input format, LAE must be run for each unit/package to be simulated. In these instances, LAE performs the function of a preprocessor for FCS. The combination of researching a unit/package movement requirement, running LAE for that requirement, and then running and analyzing output from FCS could take several hours. F-CAP is primarily an operational planning tool which can streamline procedures for war and contingency planners. The model can significantly aid the action officer in

participation in Joint Chief of Staff (JCS) exercises and, to a limited degree, program analysis.

(1) The F-CAP programs are capable of evaluating the following alternatives:

(a) Changes in unit/package configuration which result in a different number of C-141 equivalent aircraft.

(b) Changes in aircraft characteristics in terms of block speed, utilization rates, etc.

(c) Changes in the constraints on PODs and POE, e.g., load/unload time, operational hours at each airport, airfield characteristics.

(d) Changes in distances between POEs and PODs.

(e) Changes in the priority list of movement requirements.

(2) The design purpose of the F-CAP programs is for operational planning rather than program analysis. The FCS was designed to allow rapid development of air deployment plans and to assess the feasibility of those plans in supporting military operations. The model can, however, be used to evaluate a range of PDIPs affecting movement requirement changes, network changes, and changes in capabilities by evaluating changes in closure times, throughput, and aircraft tradeoff analyses.

b. Quality. The FCS methodology was verified against the manual methodology previously used by XVIII Airborne Corps using several deployment scenarios. The results of three such tests are presented in Table 5-1. The same unit, a division (-), was deployed in each scenario, with package configurations and POD restrictions and distances being the only changes. For each deployment, 100 C-141 equivalent aircraft were available. According to XVIII Airborne Corps data, 349 sorties are required to move this division (-) force. On the average, FCS computed force closure in one-tenth the time required by the manual method with an average closure time difference of less than 1 percent. The LAE was verified from two perspectives. First, it was compared against XVIII Airborne Corps' experimental sortie requirements, and second, as a closure time estimator. Using approximate deployment weights of the division (-) (exact weights were unavailable), LAE produced a sortie requirement of 377, versus 349 sorties based on experience (8 percent difference). The second test conducted as part of this study used the entire F-CAP process, verifying results with TRANSMO. LAE was used to produce the sortie requirements and FCS to simulate the deployment of 31 packages from CONUS to Korea. In this test, the closure time provided by TRANSMO for these 31 packages was 10 days, 4 hours; the closure time produced by F-CAP, 10 days, 2 hours.

Table 5-1. FCS - Manual Computation Comparison

Distance (nm)	Computation time (min)		Closure time (hrs)	
	Manual method	FCS	Manual method	FCS
3,900	250	26	147.8	148.6
1,800	230	21	81.4	80.0
1,650	275	16	145.7	147.0

(1) The FCS program is based on the following assumptions and limitations:

(a) **Ports of embarkation are open 24 hours per day.** In the simulation, all POEs are assumed to be open at all times. Since POEs are under friendly control, this assumption seems reasonable, and it simplifies the program by eliminating the need to schedule the return trip of each aircraft. The effect is to create a higher throughput at ports of debarkation because no aircraft are required to wait to take off due to scheduling constraints for returning aircraft.

(b) **Fuel is available in unlimited quantities.** It is assumed that there would be a sufficient amount of the proper types of fuel to support any operation undertaken and that the capability for in-flight refueling is available.

(c) **Program is based on one generic type aircraft.** The program is designed to run using characteristics of only one type of aircraft. Although the C-141 equivalent aircraft is most commonly used, these characteristics are under the control of the user and can be modified to represent the type of aircraft to be used in the actual deployment scheme. Additionally, the Lift Asset Estimator provides a methodology for converting one type aircraft to other types.

(d) **Unit integrity will be preserved.** The program will not violate unit (or package) integrity to better utilize cargo space. Instead, the program will round to the next whole integer the number of aircraft required to move a package. This could cause the total number of aircraft needed to move the unit to be higher than is actually necessary. If the planner desires to improve the usage of cargo space, thus lessening the number of aircraft needed, he/she can regroup packages offline that better utilize empty cargo space. This can only be done with packages departing from like POEs and arriving at like PODs.

(e) **Aircraft are not attrited during simulation.**

(f) **Only one distance is allowed to describe the deployment distance.** Even though FCS allows the use of multiple ports of embarkation and debarkation, the simulation is limited to using a single deployment distance. FCS is appropriate to use as long as the visual picture of the multiple ports in the deployment gives the appearance of a one-to-one relationship, as opposed to a one-to-many or a many-to-many relationship. For example, a plan using Pope AFB, NC, Fort Campbell, KY, and Fort Stewart, GA as POEs and Frankfurt, FRG as the POD would be an appropriate plan to use in FCS. In contrast, a plan using Pope AFB, NC and Fort Ord, CA as POEs and Frankfurt, FRG as the POD would **not** be an appropriate plan to use in FCS because of the large POE dispersion. If the visual picture shows the characteristics of a one-to-many or many-to-many relationship, it may or may not be appropriate to use FCS to assess the deployment plan. As a general rule, the greater the deployment distance, the greater the POE/POD dispersion can be without invalidating FCS results. The planner should conduct a test to determine the maximum amount of error possible due to POE/POD dispersion when using FCS and then decide if that amount of error is within acceptable limits.

(g) **Users will make necessary adjustments for PODs in different time zones from POEs.** All times in the program are based on time at the POEs. To accurately depict the hours of operation at the PODs, the user must add/subtract the difference between the time zones to the times the PODs began operations.

(2) The LAE program is based on these assumptions and limitations:

(a) **Airlift data can be represented by average values.** They are derived from several documents, including Army Force Planning Data and Assumptions (AFPDA), and Military Airlift-Airlift Planning Factors (AFP 76-2).

(b) **Lift assets and transported units arrive at the port of embarkation (POE) on time.** It is assumed that proper scheduling of arrival at POEs permits shipping without delay.

(c) **Aerial refueling is available.** This means that no reduction in aircraft payload is needed to carry extra fuel when flying beyond optimal range. If aerial refueling cannot be assumed, payload inputs must be adjusted to compensate for the lack of air-to-air refueling.

(d) **Lift Assets are not Attrited During Transit.**

(e) **Several potential delay times may have to be added to closure estimates.** Delay due to mobilization time, unit movement to POE, aircraft scheduling, POE/POD restrictions, POE/POD congestion, and adverse weather conditions are not simulated.

c. Ease of Use. F-CAP performs elementary checks for data format entry errors. All screens presented in the F-CAP programs are clear and easy for a transportation action officer to understand. The user's manual contains a very clear presentation of the F-CAP models. The novice user will have little difficulty using the software and the user's manual. Additionally, included with the user's manual is a set of "Quick Reference" cards which summarize the steps required to run each model.

5-5. CONCLUSIONS. The F-CAP program is recommended for action officer use. It can adequately calculate minimum number of aircraft needed to close a force over a given time period. Additionally, it can rapidly estimate the closure time of a force by airland or airdrop techniques working within the constraints of airlift assets and airport characteristics. This program provides flexibility in the assessment of plans and operations and a degree of usefulness in program analysis. F-CAP can be used in program analysis and is useful for those PDIPs involving changes in unit configurations, aircraft characteristics, aerial port constraints, and characteristics or changes in movement priorities.

5-6. RECOMMENDED MODEL ENHANCEMENTS

a. The LAE program should be expanded to calculate requirements for Civil Reserve Air Fleet (CRAF) passenger/cargo aircraft as these aircraft types are likely lift assets for an intertheater deployment scenario.

b. A data base should be developed containing unit specific aircraft average cargo payload data. This data base would be used in the LAE program and would eliminate the requirement to interactively enter aircraft capacities for each movement requirement.

CHAPTER 6

MINOTAUR

6-1. INTRODUCTION. This chapter describes the Minotaur Model, provides an evaluation of its capabilities, and makes recommendations for model improvements.

6-2. MODEL DESCRIPTION

a. Minotaur is an intertheater strategic deployment model and data management system developed for the Office of the Director of Program Analysis and Evaluation, Office of the Secretary of Defense. The model was developed by General Research Corporation (GRC) and is intended for use in situations where a quick analysis of a problem using a highly aggregated and simplified representation of a deployment is sufficient. The Office of the Secretary of Defense (OSD) had the model developed because they identified the need for a strategic mobility model capable of providing quick analysis which could be used to train mobility analysts and which could be used directly by analysts, wargamers, and other nontechnical personnel. The purpose of the model is to supplement the capabilities provided by the Model for Intertheater Deployment by Air and Sea (MIDAS).

b. Minotaur allows interactive decisionmaking by the user to alter the deployment in progress. The model is embedded in a system of data-editing, report-generating, graphics, and utility routines designed to make the program flexible, user-friendly, and useful in a wide range of potential scenarios. As a minimum, operation of Minotaur requires the following:

IBM PC or compatible
640K memory
Two floppy-disk drives or
  one harddisk drive and one floppydisk drive
Color/graphics display board
B/W or color monitor
Printer
8087 Math coprocessor (recommended)

c. The compiled Minotaur system is available on a single 5 1/4-inch 360K floppy disk and is not copy-protected. The program is the property of the US Government but uses certain licensed software which prevents complete source code from being made available. The program is written in Turbo Pascal.

d. Minotaur can simulate almost any deployment contingency within the limits of the resolution of the transportation networks and the forces being deployed. Table 6-1 details the upper limits on the key parameters of the model.

Table 6-1. Maximum Values of Key Minotaur Parameters

Parameter	Limit
Time periods	108
Cargo periods	10
Cargo destinations	10
Airports of embarkation (APOEs)	10
Airports of debarkation (APODs)	10
Seaports of embarkartion (SPOEs)	10
Seaports of debarkation (SPODs)	10
Cargo types	10
Supply types	3
Aircraft types	255
Ship types	255
Theaters	4
Modes	255
Requirements	1,600
Ships	1,200

e. A data base management system such as dBase III+, may be used to access and change the requirements and ship data bases. Necessary data base descriptions and formats for dBase III+ use are provided on the Minotaur program disk. Other software products with similar capabilities may also be used. The data editing features of the system allow the user to quickly develop and alter the data parameters of the model. The model makes extensive use of data prompts which facilitate its use. The report generating features of the model allow users to generate a variety of reports on the screen, printer, or on disk. The graphics interface used by Minotaur creates graphics data files which can be displayed using the Microsoft Chart graphics software and Borlands' Superkey keyboard macro program.

6-3. BASE CASE DEVELOPMENT. A complete set of Defense Guidance data for FY 94 was available for use in conducting the Minotaur evaluation. In addition to this data, Minotaur contains a set of default data which was used for familiarization purposes. In order to develop a base case for evaluation purposes, the study team used data from OMNIBUS-89 Deployment Analysis. This data was used to compare model output from CAA's TRANSMO against that of Minotaur. Simulation runs of 180 days were conducted for both models for 1,529 packages from the OMNIBUS force file. The input parameters were

identical for both models (e.g., number and type of lift assets, utilization rates). Output from several simulation runs were compared to ascertain whether or not the Minotaur simulation output appeared to be reasonable. Closure times for the packages from both the Minotaur and TRANSMO were quite similar. Although differences in closure times did occur in some instances, differences in output could logically be attributed to the fact that TRANSMO uses generic sealift assets that have average speed and cargo capabilities associated with them, whereas Minotaur uses actual characteristics of sealift assets by individual hull number. There are other model subtleties that could cause variations.

6-4. EVALUATION

a. Applicability

(1) Assuming data availability, Minotaur does not require much time to set up prior to operation. All parameter data, scenario description data, network data, aircraft data, some of the ship data, and some of the supply calculation data are input directly by the user during an interactive session. The remaining input data include the ship characteristics and availability file and the requirements data files. A complete data set of Defense Guidance FY 94 data has been developed by GRC and is available for use. Since Minotaur is limited to a maximum value of 1,600 separate movement requirements, the development of a movement requirements file for a global scenario requires some forethought and time to prepare. Currently, OSD, PAE is using a mainframe program to aggregate movement requirements to meet the Minotaur limit. Unless this or a similar aggregation program capability is provided to the user, one would be required to build a requirements file. This task would most likely be beyond the technical capability of the action officer. It is understood, however, that PAE intends to make an annual DG scenario file available for the services.

(2) Assuming a complete movement requirements file is available, a complete analytical task should be completed in less than 4 hours. This process includes problem identification, modification of model input, model operation, report generation, and output analysis. The response time of the model is dependent on the individual functional modules. When running Minotaur on a hard disk drive, the maximum time required to schedule a deployment (simulation module) without user interaction with the program should not exceed 30 minutes. The speed is degraded slightly when operating the model on a system configured with only a floppy disk drive.

(3) The technical expertise and training background of a transportation AO is more than adequate to successfully operate Minotaur and conduct analysis of the model's output. The model was specifically developed for mobility analysts, wargamers, and nontechnical personnel.

(4) Use of the model should assist the AO in planning strategic mobility requirements for The Army Plan, developing requirements for the Program Objective Memorandum (POM), and developing lift requirements, assessing closure capabilities, and performing "what-if" analysis. The AO can more easily address transportation system change capabilities by running the model, modifying base case inputs to reflect changes in capabilities/requirements, and comparing model output to base case outputs to assess the

assess the impact on the transportation system. As a result, AOs should have more time to provide analysis of issues and exploration of numerous alternatives and their consequences.

(5) Minotaur has the capability to improve the organizational information flow of issues and matters pertaining to program analysis. Use of the model can provide insight into the impact of various PDIPs pertaining to intertheater deployment. The model's output does not, however, directly address PDIP analysis. The action officer must translate the PDIP into a model scenario, run the model against a base case, and independently conduct output analysis to determine the impact of the specific PDIP versus the base case output. For example, a PDIP that changes a unit from a non-POMCUS (prepositioned materiel configured to unit sets) unit to a POMCUS unit would have various impacts upon the strategic mobility arena. In defending this PDIP, or arguing against it, the action officer would want to present the decisionmaker with information to enhance the decisionmaking process. In this particular case, a change would certainly impact upon the movement requirements for this unit. One would intuitively think that if we were to preposition some of the unit's equipment, we could have this unit arrive earlier and possibly free otherwise committed transportation assets to move additional units and supplies. The impact of this action can be modeled directly with Minotaur, and the impact of this change can be shown by comparing arrival schedules of a global deployment with the two scenarios. Comparison of the arrival schedules can show the impact of this action upon unit closures.

(6) Data management for Minotaur is relatively easy. Much of the model input is self-contained and can be updated interactively. Minotaur makes extensive use of data prompts which facilitate the updating process. Data editing features of the system allow the user to quickly develop and alter the data parameters of the model. Base case scenario files and special simulation runs can be saved as files and be used for comparison purposes, should the user so desire. Updating and changing the requirement data file and ship data file requires a greater level of computer expertise. These data bases cannot be updated or changed interactively. To change these files, the user can use dBase III+. Necessary data base descriptions and formats for this purpose are provided on the Minotaur program disk. Since the ships and requirements file are text files, they can also be changed by use of a word processing program such as PC Write. Should the user desire to use a new set of movement requirements, one would have to construct an entirely new file for that purpose. A planned enhancement to the model that has not been implemented in the current version of Minotaur is a requirements editor. This editor will allow the user to build movement requirements from generic forces data.

b. Quality

(1) Minotaur does not provide all the capabilities of MIDAS and other mainframe deployment models. The data bases required to capture such detail are beyond storage capacities of PCs. Recognizing these limitations and the intended purpose of Minotaur, its assumptions are justifiable. Some of the model's limitations and assumptions include the following: Port constraints at seaports and airports are not modeled. The assembly of convoys is not simulated. Movement of aircraft is treated as a productivity calculation,

and aircraft assumed to complete their mission in 1 day rather than explicitly moved by simulation.

(2) Given the model's assumptions and limitations, the Minotaur methodology is sound. Minotaur simulates the deployment using a heuristic scheduling process. Scheduling heuristics are arbitrary rules used to assign cargo to ships and aircraft. This approach is an acceptable method to deal with the problem. The heuristic rules are intended to produce results which are generally accepted as near the optimal solution. The principal advantage of heuristics is that they are easy to formulate and produce fast-running results. The model attempts to schedule cargos to be delivered by their RDD or within a window prior to RDD if utilization of transportation assets will be improved by early movement.

(3) Minotaur was not completely validated at the time of the team's evaluation. The developer has made some validation runs with MIDAS and has stated that results compared favorably with Minotaur output. The TRIPM study team also compared several TRANSMO runs against those of Minotaur. These, too, compared favorably.

c. Ease of Use

(1) Minotaur is completely menu-driven. The main menu program provides three utility options and five modeling options. The utility options are available to make it easier for the user to prepare and manage Minotaur data files. These options permit the user to list, copy, and delete sets of data base files. The modeling options menus include calling the input data editing routines, running the simulation model, and three options to generate reports and graphs. There is no provision to use an optional command language to bypass the menu-driven system in the current version of the model. The absence of the ability to drive the model via an optional command language capability is not considered to be a detriment to Minotaur because the model performs so quickly in its present format.

(2) In the current version of the model, there are no standard reports generated as a result of a deployment simulation. The output of the model is accessed by selecting one of several interactive interfaces from the output menu. The report generating routines allow the user to select a subset of movements generated by the model (e.g., all Army movements to North Atlantic Treaty Organization (NATO) with an RDD less than 045), sort them in any order, and generate tabular reports. Generating reports is a relatively easy process. The user is guided through the report generating process by a series of easy-to-follow menus.

6-5. CONCLUSIONS. Minotaur is recommended for action officer use. The model has the capability to improve the organizational information flow of issues and matters pertaining to program analysis. Use of Minotaur should assist the AO in planning strategic mobility requirements for The Army Plan, developing requirements for the POM, and developing lift requirements, closure capabilities, and "what-if" analysis. The AO can more easily address transportation system change capabilities by running the model, modifying base case inputs to reflect changes in capabilities/requirements, and analyzing model output to assess the impact on the transportation system.

6-6. RECOMMENDED MODEL ENHANCEMENTS

a. The model should have the capability to display queue lengths at various nodes of the system. This data should be capable of being displayed by any of current output data elements of Minotaur (e.g. by day, cargo type, container weight, noncontainer weight, etc.).

b. In its present format, Minotaur does not have the capability to output information pertaining to the utilization of lift assets. An extremely useful modification would be the ability to display lift asset idle time by ship type, aircraft type and POE for each time period of the simulation run. Additionally, the model should be able to identify, by day and POE, the number of aircraft available, number of missions flown, and the amount of cargo and number of personnel delivered.

c. The model should be able to calculate the deviation of estimated delivery dates from required delivery dates for each movement requirement. Currently, the user is capable of displaying only the delivery dates and required delivery dates as output.

d. The user should have the optional capability to capture and display a listing for key Minotaur parameters and inputs as part of each Minotaur simulation run. For example, assume a user needs to conduct several sensitivity runs of a deployment changing several variables. It would be very helpful to be able to display a listing of the model's key parameters as part of the output. Data should include scenario data, network data, aircraft data, and ship data. Scenario data should include the following: names of origins, destinations, sea and airports, theaters, ship types, mobilization dates, deployment dates, origin to SPOE travel times, SPOD to destination travel times, APOD to destination travel times, and in-theater marry-up times. Network data should include APOE to APOD distances and SPOE to SPOD distances. Aircraft data should include aircraft names, speed, payload, availability, and utilization rates. Ship data should include names and quantity of ship type, ship fleet, and stowage factors for containerized and noncontainerized cargo.

e. Currently, charts and graphs can only be output to a printer. This should be expanded to the capability to output charts and graphs to the computer screen in order to view the output prior to printing a hard copy.

CHAPTER 7

FINDINGS AND OBSERVATIONS

7-1. **PURPOSE.** The purpose of this chapter is to address the essential elements of analysis required of the study, to present key findings and observations, and to summarize the study.

7-2. **ESSENTIAL ELEMENTS OF ANALYSIS.** The study directive contains the following EEAs:

a. What are the transportation analytical requirements generated by PDIPs? PDIPs are classified by functional panel. Each PDIP can be viewed with its own set of strategic mobility implications and analytical requirements. We have defined "analytical requirements" to be in the form of questions which must be answered analytically with quantitative rather than qualitative results.

(1) The basic analytic requirement, therefore, is the question: what effect does a given PDIP and its funding level have on the global transportation system? As an alternative question, what effect does the change in funding of a given PDIP have on the transportation system? This second question is critical in performing program analysis in order to determine where funding cuts will hurt the transportation system the least, or conversely, where increases in funding can best be spent. The following are quantitative MOE against which PDIP funding level changes may be compared:

- Deviation of RDD from actual delivery date.
- Number of idle resources per unit of time.
- Percent utilization of lift assets.
- Average time in queue of lift assets.

The basic measure of a PDIP's worth to the transportation system is in the form of better utilization of assets and in timely closure of forces to theaters of operation. For each functional panel, one or more strategic mobility implications were identified and are displayed in Table 7-1

Table 7-1. Transportation Analytical Requirements Generated by PDIPs

PDIP functional panel	Strategic mobility implication
Structuring	Change in movement requirements
Manning	Increased transportation unit readiness Change in movement requirements
Training	Increased transportation unit readiness More efficient/faster deployments
Providing facilities	Upgrade of network, nodes and links of the transportation system
Managing information	Upgrade management of transportation system Increase productivity of system
Equipping	Change in movement requirements Increased transportation unit/facility capability
Sustaining	Upgrade management of transportation system Increase productivity of system
Managing	Upgrade management of transportation system Increase productivity of system
Mobilizing/deploying	Direct impacts on transportation system

(2) The study team examined the 90 PDIPs for the FY 88-92 budget of the Mobilizing/Deploying Panel. The implications of these PDIPs were investigated and are displayed in Table 7-2.

Table 7-2. Sample of Mobilizing/Deploying PDIPs from FY 88-92 Budget

PDIP type	Strategic mobility implication
Reserv Components (RC) unit upgrade/ nontraining	Easier deployment due to better mobilization training--earlier availability dates Increased movement requirements due to additional equipment/personnel
RC system upgrade, including facilities	Better facilities and management results in faster deployment May increase movement requirements
Combat service support (CSS) capability (new/ upgrade) including medical facilities and procurement	Better battlefield sustainment Increased movement requirements
Prepositioning war stocks and prepositioning system upgrade	Fewer movement requirements More efficient management/deployments
Upgrade strategic mobility links (rail, highway)	Modification of strategic mobility network Shorter transit times over network Faster deployments
Node/staging base creation/upgrade	Network modification Faster throughput at node Higher node capacity
Mobilization system upgrade to include management upgrades	More efficient deployment Faster deployment/change in movement requirements
Industrial preparedness upgrade	Easier industrial surge Change in movement requirements More lift assets available sooner
Mobilization training increase/facility up- grade to include mobilization exercises (MOBEXs)	Change in movement requirements Increased readiness, i.e., earlier availability dates
Procurement of strategic mobility equipment in- cluding LOTS	Direct capability increase in specific area of fielding
Mobilization equipment procurement including construction	Increased mobilization capability Change in movement requirements Change in lift assets/links/network

b. **What kind of transportation PDIP analysis and resource changes can PC-based models evaluate?** Existing PC-based models cannot currently make the translation from a funding change to model inputs (change in movement requirements, network/node/link change, or capability change). That task is extremely difficult and rather subjective. The problem is translating dollar changes to changes in capability (assets and movements requirements). The problem of translating PDIP funding into model input must be done by the AO. The AO goes through a complex procedure in deciding what type of funds are involved, where the funds must be cut, proportionately distributing the cut, and then determining the impacts, e.g., reduction of capability or closure time. This procedure differs from AO to AO. Each model recommended for AO use was assessed on its ability to analyze funding and resource changes. The results are summarized in Table 7-3, which is organized by PDIP type (determined from EEA 1) and model. Clearly, no existing model can perform an analysis of all types of PDIPs and funding changes. A combination of models, however, may fulfill most analytic requirements.

Table 7-3. Evaluation of Transportation PDIP and Resource Change Analysis

Kinds of PDIPs	Airlift/ Sealift	Minotaur	F-CAP
Change in movement requirements	Yes	Yes	Yes
Unit readiness change	No	Limited	Limited
Network change	Limited	Yes	Limited
Transportation system management change	No	No	No
Increased capability	Yes	Yes	Yes

c. **How can each PC-based model be used to evaluate the impact of each kind of transportation PDIP analysis and resource change?** Table 7-4 lists several examples of how the recommended PC-based models can be used in evaluating the impact of transportation-related PDIPs and resource changes.

Table 7-4. Model Use in Evaluating the Impact of PDIP Analysis and Resource Changes

Model	Kinds of PDIPs	Method of model use
Minotaur	Movement rqmts change	Analyze deployment closure profile resulting from changes in RDD/LAD, avail dates, and new requirements
	Increased capability	Evaluate lift asset utilization and closure profiles resulting from changed lift characteristics and capabilities
F-CAP	Movement rqmts change	Evaluate unit closure times, estimate throughput requirements, and conduct A/C tradeoff analysis by: Changing cargo/units deploying
	Unit readiness change	Changing equipment characteristics Changing availability factors of equipment
	Network change	Modifying nodes, links Changing cargo routing
	Increased capability	Modifying/building new capability Changing cargo routing
Airlift/ Sealift	Movement rqmts change Increased capability	Evaluate deployment time estimates and number of aircraft required by: Changing cargo to deploy Adding/modifying lift asset characteristics

d. What modifications must be made to the PC-based models to enable transportation action officers to use the models for program analysis? Table 7-5 contains the key modifications that can best enhance the models' usefulness for program analysis. The recommended modifications are limited to those which are deemed appropriate for implementation considering the models' design, architecture, and complexity.

7-3. KEY FINDINGS. In their present form, the models evaluated are of limited use in the evaluation of transportation PDIP changes.

a. No model was capable of directly evaluating the impact of funding changes; however, PDIP analysis can be conducted by converting funding charges to appropriate model input parameters and data.

b. If modified as recommended, the models evaluated have the potential to become significantly more useful in PDIP analysis.

c. All the evaluated models have use in the area of operational planning and exercises.

Table 7-5. Recommended Model Modifications

Model	Shortfall	Modification
Airlift/ Sealift	Simple weight methodology provides only gross estimates of aircraft closures and capacity	Aircraft capacity should reflect cargo density and aircraft cargo compartment dimensions used
F-CAP	Based upon generic aircraft type - C-141 equivalent	Capability of simulation by individual aircraft types
	Data entry is time-intensive and must be done interactively	Capability to input data via files as well as interactively
	Lack of internal data base with aircraft cargo payload data	Add data base containing specific aircraft payload data from AFPDA
Minotaur	Inability to simulate attrition lift assets	Add an attrition algorithm
	Inability to simulate convoys	Add capability to form convoys as part of scenario data
	Inability to constrain transportation network	Ability to model port constraints as an input parameter
	Inability to capture lift asset utilization data	Capture and display lift asset utilization data for each vehicle in simulation
	Does not track cargo backlog at various nodes	Capture queue length data at each node

7-4. RECOMMENDATIONS

a. DCSLOG action officers should use the Airlift/Sealift, Minotaur, and F-CAP Models as tools in evaluating the impact of resource changes and POIP analysis.

b. The experience gained by the use of these models should be used as a basis for further defining the requirements of the strategic mobility module of the LOG DSS.

c. The PC models should be modified as recommended to improve their usefulness in program analysis. Specific modifications and enhancements are contained in Chapters 4, 5, and 6 of this study.

e. As the models are modified and DSS requirements are further defined, a mainframe version of the models should be transferred to the HQDA Decision Support System to take advantage of the analytical tools and data availability that are elements of the system.

7-5. STUDY SUMMARY. This study identified the transportation analytical requirements which are generated by PDIPs and identified several PC-based transportation models which can be used to assist DCSLOG action officers in evaluating the impact of PDIPs and resource changes. Additionally, this study identified how each of these models can be used to evaluate the impact of various kinds of transportation PDIPs and resource changes. The study also recommended several changes to the models which, if adopted, have the potential to significantly improve the models' capability to perform program analysis.

APPENDIX A

STUDY CONTRIBUTORS

1. STUDY TEAM

   a. **Study Director**

   MAJ Robert G. Albrecht, Jr., Strategy and Plans Directorate

   b. **Team Members**

   CPT Joseph W. Mislinski

   Ms. Tara King

   c. **Other Contributors**

   LTC Robert J. Peresich

2. PRODUCT REVIEW BOARD

   Mr. Howard G. Whitley III, Chairman

   LTC Marshall D. Martin

   Mr. Stanley H. Miller

APPENDIX B

STUDY DIRECTIVE

DEPARTMENT OF THE ARMY
OFFICE OF THE DEPUTY CHIEF OF STAFF FOR LOGISTICS
WASHINGTON, D.C. 20310-05

18 JUN 1987

DALO-TSM (1-21) (5-5c)

MEMORANDUM FOR: Director, U. S. Army Concepts Analysis Agency, 8120 Woodmont Avenue, Bethesda, MD 20814-2797

SUBJECT: Army Strategic Mobility System Assessment (ASMSA)

1. References:

a. HQDA DCSLOG Study Directive, dated 1 Dec 86, subject as above.

b. Letter, CSCA-SPM, dated 27 Apr 85 (sic), subject: Transportation Improvement Program 3 (TRIP3) Army Strategic Mobility System Assessment (ASMSA).

2. Reference 1a directed initiation of Phase II of the Army Strategic Mobility System Assessment (ASMSA). Reference 1b recommended revision of reference 1a to reflect reevaluation of CAA capabilities to develop the Strategic Mobility Module of the ODCSLOG Decision Support System, and to develop an interface for PC based models.

3. Reference 1a is revised as follows:

a. Add to paragraph 3 the following sub-paragraph c:

Develop a methodology for conducting an inter/intratheater transportation study and provide a transportation study for the NEA theater.

b. Delete the last sentence of paragraph 6a(1).

c. Substitute the following for paragraph 6a(2)(c):

PC based transportation models (MOVER, SHAKER, Mini-MIDAS, Airlift/Sealift) will be assessed to determine their utility for use by action officers on the PC. Following the assessment, models will be provided to TSM, along with parametric data bases when sufficient default data is not contained in the model, training, and a suitable JPAM-based requirements data base.

d. Substitute the following for paragraph 6b(2):

(a) Develop the concept paper and functional description to support development of the Strategic Mobility Module of the ODCSLOG DSS.

(b) Assess and provide PC based transportation models.

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e. In paragraph 6e, change the date for the availability of Shaker to September 1987 and Mini-MIDAS to June 1987.

f. Substitute the following for paragraph 6f(2):

(2) Programming.

(a) What are the strategic mobility system assessment requirements generated by PDIPs?

(b) What kind of strategic mobility related PDIP analysis and resource changes can PC-based models evaluate?

(c) How can each PC-based model be used to evaluate the impact of each kind of strategic mobility system related PDIP analysis and resource change?

(d) What PC-based model modifications must be made to enable Strategic Mobility Division action officers to use the model for program analysis?

g. Add the following as paragraph 6i:

Limitations. Attrition and retrograde movement requirements will not be simulated in the NEA planning study or PC-based models; however both will be included as a functional requirement in the Functional Description.

h. Delete paragraph 7b(4).

i. Add the following as paragraph 9b(12):

DOD 7935.1-STD, Automated Data Systems (ADS) Documentation Standards, Office of the Assistant Secretary of Defense (Comptroller), 24 April 1984.

j. Change paragraph 10b Milestones to read:

(1) Complete Concept Paper and Functional Description	Mar 87
(2) Publish NEA study report	Dec 87
(3) Complete Model Evaluation/ Documentation	Apr 88

k. Change paragraph 10d Phase II Deliverables to read:

(1) Concept paper and functional description documenting user requirements for the Strategic Mobility Module.

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(2) Study report documenting a methodology for conducting an inter/intratheater transportation study and providing results of a transportation study for the NEA theater.

(3) Copies of the PC-based models' software disks and supporting parametric and requirements data base disks. An assessment of the models' documentation, operation, and recommended modifications for model use will also be provided.

4. Reference 1a as amended by this document constitutes the ASMSA Phase II study directive.

FOR THE DEPUTY CHIEF OF STAFF FOR LOGISTICS:

Paul C. Hurley
PAUL C. HURLEY
Brigadier General, GS
Sponsor's Study Director

DEPARTMENT OF THE ARMY
DEPUTY CHIEF OF STAFF FOR LOGISTICS
WASHINGTON, D.C. 20310-0500

DALO-TSM (2-82) 465 '5L 1 DEC 1986

SUBJECT: Army Strategic Mobility System Assessment (ASMSA)

Director
U. S. Army Concepts Analysis Agency
8120 Woodmont Avenue
Bethesda, MD 20814-2797

1. PURPOSE OF STUDY DIRECTIVE. This directive authorizes the initiation of Phase II of the Army Strategic Mobility System Assessment (ASMSA). This will continue the development of a process that objectively evaluates the total strategic mobility system and optimizes total system performance given present and proposed policies, and procedural and funding strategies that impact on the transportation system. It is a direct follow-on to the ASMSA Phase I feasibility study and will provide a near term analytic capability using existing transportation models and the ODCSLOG Decision Support System (DSS). ASMSA Phase II will also provide a basis for the long term development of an ASMSA prototype using new and emerging state of the art automation capabilities.

2. BACKGROUND. The Army has made considerable progress toward improving its capability to project and sustain forces. Many aspects of the mobility system have been the focus of aggressive but often independent initiatives. There is concern that the system's net throughput may not be improved because of remaining unrecognized bottlenecks. This concern led to a DCSLOG initiative to find a mechanism for systematically evaluating and improving the net capability of the total transportation system, hence, ASMSA. Phase I of ASMSA was a study to determine the feasibility of designing a transportation analysis process to assist ODCSLOG in reviewing the adequacy of strategic mobility policies and programs and in developing inputs to the Program Objective Memorandum (POM) development process. The U. S. Army Concepts Analysis Agency (CAA), the study agency, determined that ASMSA is feasible and provided recommendations for development.

3. PURPOSE OF THE STUDY. The overall ASMSA initiative outlines a progressive, multi-phased, long range effort to provide the analytical means to define mobility requirements, capabilities and shortfalls and identify actions which will result in the

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greatest improvement to overall system delivery capability. The final objective is to assure a balanced total transportation system. The purpose of Phase II is to:

a. Provide a near term analytical capability that will give action officers in the Strategic Mobility Division, HQDA, a quick response interface with existing models to assess the state of the strategic mobility system and begin to determine where resources can be applied most profitably.

b. Serve as a baseline for the long term development of a state of the art automated decision support system that can meet ODCSLOG-unique transportation analytic needs.

4. STUDY SPONSOR. Office of the Deputy Chief of Staff for Logistics (ODCSLOG). Sponsor's Study Director (SSD) - Director for Transportation, Energy and Troop Support (DTRETS).

5. STUDY AGENCY. U. S. Army Concepts Analysis Agency (CAA).

6. TERMS OF REFERENCE.

a. Scope.

(1) The ASMSA process must be capable of evaluating the movement of programed Army forces and sustaining supplies from their origins to and through aerial and sea ports of embarkation, to and through worldwide theater ports of debarkation, and onward to final destinations for employment. The process must permit sensitivity analysis of all aspects of transportation required to mobilize, deploy, and sustain Army forces worldwide. The transportation system's constraints and limitations must be identified in ways that lead directly to recommended changes in transportation policies, procedures, and funding through the program years. In addition, the process must be able to analyze the transportation system's capability and its sensitivity to the prioritization of such variables as time, money, force structure, etc. Follow-on phases to Phase II will include: continued modification of quick response transportation models; the development of a functional description following the points of analysis of the Strategic Mobility Module statement of work and the ASMSA Study Report; and, the development of a prototype transportation model.

(2) Phase II Scope.

(a) ASMSA Phase II will provide a process to evaluate the movement of programed Army forces from CONUS through sea and

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aerial ports of embarkation, to and through a theater port of debarkation and onward to the ultimate destinations. Movement of personnel or cargo below the Corps level will not be considered. Also this phase will not include a detailed description of the CONUS transportation network or the information subsystem.

(b) The process will link main frame models (TRANSMO-SITAP) for simulation and analysis to identify bottlenecks and shortfalls in the transportation system in support of the development of The Army Plan (TAP) input and formulation of program input.

(c) A customized interface will be constructed for the PC based models (MOVER, SHAKER, Mini-MIDAS) as they become available. They will be used in support of a quick response capability for programing analysis.

(d) Phase II will include the points of analysis contained in subtask 7a, "Develop Prototype and Functional Description for Strategic Mobility Module, work statement for Logistics Decision Support System" (attached as an Addendum), and the DSS requirements specified in ASMSA Study Report 1 Sep 85.

b. Objective. To provide a near term capability for ODCSLOG to meet strategic mobility programing and planning requirements. This capability will be used as a foundation for the continued development of a DSS in future phases. Specifically,

(1) Planning. Develop a methodology at CAA to perform transportation planning studies for DCSLOG and demonstrate this methodology through a transportation analysis of a single theater of operations.

(2) Programing.

(a) Implement a Management Information System (MIS) to allow access to standard data bases and extraction of information in desired formats (i.e., reports, graphics) to support ODCSLOG strategic mobility analysis.

(b) Develop a quick response capability for intertheater and intratheater mobility analysis to allow ODCSLOG to assist in mobility program development and program change assessment.

c. Timeframe. The Phase II effort shall be structured to support the development of the 1990-1994 POM.

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d. Constraints.

(1) Providing all data bases for use of the action officer at his work station is dependent upon secure communications lines from the host computer to DALO-TSM.

(2) The Management Information System and mini-models must conform to the specifications of the Logistics DSS.

e. Assumptions. Identified mini-models will be available at CAA by the following specified times:

(1) MOVER - December 1986;

(2) SHAKER - April 1987; and

(3) Mini-MIDAS - February 1987.

f. Essential Elements of Analysis (EEA).

(1) Planning.

(a) During the deployment and sustainment of the Northeast Asia (NEA) theater of operations, what are the transportation system bottlenecks and shortfalls for inter- and intratheater movements? (NEA selected due to availability of MTMC Korean Port Study for comparison.)

(b) What are policy and procedure changes which can be implemented to reduce bottlenecks and shortfalls? What is the effect on cargo delivery of implementing new policy and procedural guidance?

(c) Where personnel, facilities and equipment contribute to shortfalls and bottlenecks, what additional resources or reallocation of resources are required to alleviate the problem areas?

(d) What is the effect on cargo flow of readding/reallocating resources to critical links in the transportation network?

(2) Programing. What are the changes to transportation system flow resulting from identified program modifications (PDIPs)?

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g. Environmental and threat guidance. No environmental impact is anticipated; however, the study sponsor will address any environmental considerations that develop during the study or as a result of its application.

h. Estimated cost savings. This study effort has the potential to generate cost savings; however, they cannot be quantified at this time.

7. RESPONSIBILITIES.

a. The ODCSLOG will:

(1) Provide a study sponsor's technical representative.

(2) Establish a Study Advisory Group (SAG) and designate a Chairperson.

(3) Designate or identify a point of contact (POC) at MACOMs, TOAs, and other agencies as required.

(4) Keep CAA advised of the DCSLOG Logistics Program Module (LPM) in-process reviews, SAGs and critical changes affecting the DCSLOG LPM development effort.

b. CAA will:

(1) Designate a study director and establish a full-time study team.

(2) Establish direct communication with ODCSLOG and other agencies as required for the conduct of the study.

(3) Provide periodic in-process reviews (IPR) and final study documentation to the study sponsor.

(4) Provide programing and ADP support as required for the conduct of the study.

8. LITERATURE SEARCH.

a. OSD strategic mobility studies.

b. JCS strategic mobility studies.

c. MTMC CONUS deployability studies, port capacity analyses, and installation outloading capability studies.

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SUBJECT: Army Strategic Mobility System Assessment (ASMSA)

9. REFERENCES.

a. Administrative.

(1) AR 5-5, The Army Study Program.

(2) DA Pamphlet 5-5, Guidance for Study Sponsors and Study Advisory Groups.

b. Substantive.

(1) CAA-SR-86-25, Army Strategic Mobility System Assessment, September 1986.

(2) Joint Program Assessment Memorandum (JPAM) FY 88-92, April 1986.

(3) Work statement for Logistics Decision Support System, March 1986.

(4) Simulator for Transportation Analysis and Planning (SITAP) User's Manual, 30 September 1977.

(5) Transportation Model (TRANSMO) Software Documentation (TRANSMO Users Manual), January 1983.

(6) TRANSMO Users Manual Addendum, November 1983.

(7) MOVER Model Documentation Manuals, Information Spectrum, Inc., 1986.

(8) SHAKER Simulation Model, SAG meeting, October 1986.

(9) Mini-MIDAS (Multi-optioned Interactive and Analytic System) Functional Description (Draft), January 1986.

(10) U. S. Army Unit Level Enlisted Strength and Personnel Management Actions FORECAST System, System Development Plan Stage II (Draft), March 1984.

(11) The Korean Ports and Transportation Capability Study, MTMC Report TE 83-3h-46.

10. ADMINISTRATION.

a. Support.

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SUBJECT: Army Strategic Mobility System Assessment (ASMSA)

(1) Funding for temporary duty (TDY) and travel associated with the study will be provided by each participating agency.

(2) Automatic data processing equipment (ADPE) will be provided by both CAA and ODCSLOG.

b. Milestone Schedule.

(1)	Study Plan/Study Directive Approval	Dec 86
(2)	IPR Planning and Programing (MOVER/MIS)	Mar 87
(3)	SAG Planning and Programing Results	Oct 87
(4)	Publish Study Report and Model Demonstration	Dec 87

c. Control Procedures.

(1) The ODCSLOG will designate a SAG chairperson. Periodic IPR will be provided to the SAG.

(2) The ODCSLOG study technical representative will serve as the day-to-day contact for the study within the ARSTAF.

d. Phase II Deliverables.

(1) A Study Report documenting a methodology for a detailed analytic assessment of the transportation system using TRANSMO-SITAP models to assist DALO-TSM in meeting their Army Plan analysis requirements.

(2) A User's Manual documenting the user requirements for the operation of the PC based mini-models.

(3) A User's Manual documenting the operation of the Management Information System.

e. Coordination. This study directive has been coordinated with CAA in accordance with AR 10-38.

Benjamin F. Register Jr.
BENJAMIN F. REGISTER, JR.
Lieutenant General, GS
Deputy Chief of Staff
for Logistics

7

APPENDIX C

BIBLIOGRAPHY

DEPARTMENT OF THE ARMY

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Force Closure Analysis Program (F-CAP), A Tool for Operational Planners, CAA-D-87-11, US Army Concepts Analysis Agency, Bethesda, MD, September 1987

Transportation Improvement Program Requirements (TRIPR): Functional Description of the Strategic Mobility Module, CAA-D-87-2, US Army Concepts Analysis Agency, Bethesda, MD, March 1987

Military Traffic Management Command (MTMC)

MTMC Pamphlet 700-1, Logistics Handbook for Strategic Mobility Planning, January 1986

The Korean Ports and Transportation Capability Study, Volume III, Intertheater Movement, MTMC Report, TE 83-h-46. <au 1984

MISCELLANEOUS

Documentation Manuals - Mover Model, Information Spectrum, Inc., Arlington, VA, June 1987

User's Guide, Intratheater Transportation Simulation (ITRANS), Interactive Microcomputer Applications, Potomac, MD, 1987

User's Manual for the Minotaur System, Report 1419-07-88-CR, General Research Corporation, McLean, VA, January 1988

APPENDIX D

MODEL EVALUATION CRITERIA

D-1. PURPOSE. The purpose of this appendix is to explain the criteria used to evaluate the PC-based transportation models chosen as potential candidates for action officer use in program analysis. The evaluation criteria were developed jointly by the study team and the sponsor, DCSLOG.

D-2. EVALUATION CRITERIA. The following criteria were used in the evaluation of each model.

a. Applicability. The model must be applicable to the sponsor's needs, problems, and environment. The model should be able to:

(1) Evaluate a range of transportation systems, e.g., intratheater, intertheater, CONUS, fixed port, and/or LOTS.

(2) Be set up and run in a timely manner.

(3) Perform various types of analyses and "what-if" alternatives.

(4) Evaluate PDIP impact changes.

b. Quality. The model must be analytically sound. The model should be able to:

(1) Reflect an adequate functional representation of the real-world system based on logical assumptions.

(2) Run error free.

(3) Produce logical results.

c. Ease of Use. Action officers must be capable of using the model with relative ease. In order to meet this criteria, the model must be:

(1) Easy to learn and understand with good user interface.

(2) Contain clear, concise, and understandable user's manuals and documentation.

(3) Input data must be readily available.

(4) Input/output formats must be meaningful, understandable, and flexible.

APPENDIX E

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GLOSSARY

ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

ADP	automatic data processing
AFPDA	Army Force Planning Data and Assumptions (study)
ammo	ammunition
AO	action officer
APOD	airports of debarkation
APOE	airports of embarkation
ASMSA	Army Strategic Mobility System Assessment
avail	available; availability
CAA	US Army Concepts Analysis Agency
CAMP	Computer Assisted Match Program
CONUS	continental United States
CRAF	Civil Reserve Air Fleet
CS	combat support
CSS	combat service support
DA	Department of the Army
DCSLOG	Deputy Chief of Staff for Logistics
DG IPS	Defense Guidance Illustrative Planning Scenario
DOD	Department of Defense
DSS	decision support system
EEA	essential element(s) of analysis
F-CAP	Force Closure Analysis Program
FCS	Force Closure Simulation
GRC	General Research Corporation
HQDA	Headquarters, Department of the Army
IMA	Interactive Microcomputer Applications, Inc.

ITRANS	Intratheater Transportation Simulation
JCS	Joint Chiefs of Staff
JOPS	Joint Operation Planning System
JPAM	Joint Program Assessment Memorandum
JSCP	Joint Strategic Planning Document
LAD	latest arrival date
LAE	Lift Asset Estimator
LOTS	logistics over the shore
MIDAS	Model for Intertheater Deployment by Air and Sea
MOBEX	mobilization exercise
MOE	measure of effectiveness
MOG	missions on the ground
MTMC	Military Traffic Management Command
MTON	measurement ton (40 cubic feet)
NATO	North Atlantic Treaty Organization
NEA	Northeast Asia
nm	nautical miles
ODCSLOG	Office of the Deputy Chief of Staff for Logistics
OMNIBUS	US Army Operational Readiness Analysis
OPLAN	operation plan
OSD	Office of the Secretary of Defense
PC	personal computer
PDIP	Program Development Increment Package
PFT	Program Force Type Unit Characteristics File
POD	port of debarkation
POE	port of embarkation
POM	Program Objective Memorandum

POMCUS	prepositioned materiel configured to unit sets
PPBES	planning, programing, budgeting, and execution system
RC	Reserve Componets
RDD	required delivery date
RO/RO	roll on/roll off (ship)
rqmt	requirement
SLAM	Simulation Language for Alternative Modeling
SPOD	seaport of debarkation
SPOE	seaport of embarkation
sq ft	square feet
SRC	standard requirement code
STON(S)	short ton(s)
TPFDD	Time-Phased Force Deployment Data
TPSN	troop program sequence number
trans	transportation
TRANSMO	Transportation Model
TUCHA	Type Unit Characteristics File
UFSS	ultra-fast surface ship
UIC	unit identification code

CAA (Concepts Analysis Agency, United States Army)	TRANSPORTATION IMPROVEMENT PROGRAM - MODELS (TRIPM)	STUDY SUMMARY CAA-SR-88-34

THE REASON FOR PERFORMING THE STUDY was to assess available PC-based transportation models to determine their utility for use by Deputy Chief of Staff for Logistics (DCSLOG) action officers in conducting analysis of the Army's transportation program.

THE PRINCIPAL FINDINGS are that currently available transportation models (Airlift/Sealift, Force Closure Analysis Program (F-CAP), and Minotaur) which were reviewed are of limited use in their present form in the evaluation of transportation program changes; however,

(1) Limited program analysis can be conducted indirectly by translating funding changes to appropriate changes in model data affecting transportation assets and networks.

(2) If modified, the evaluated models have potential to become significantly more useful in program analysis.

(3) The evaluated models have potential for greater use in the area of operational planning and exercises.

THE MAIN ASSUMPTIONS are as follows:

(1) Suitable PC-based models exist which would lend themselves to use by DCSLOG action officers in analyzing the Army's transportation program.

(2) PC-based models identified as appropriate for DCSLOG action officers use can be converted to a mainframe version and transferred to the Headquarters, Department of Army (HQDA) Decision Support System (DSS) as elements of the Strategic Mobility Module.

THE PRINCIPAL LIMITATION of the study is that the feasibility and total cost of modifying the PC-based transportation models for mainframe use has not been addressed.

THE SCOPE OF THE STUDY is to review currently available PC-based transportation models.

THE STUDY OBJECTIVES are to: (1) evaluate PC-based transportation models to support quick response program analysis, (2) recommend model modifications that would improve the model's usefulness in evaluating the impact of transportation resource changes, and (3) train action officers in the use of recommended models.

THE BASIC APPROACH was to conduct research on the availability of PC-based transportation models. A list of candidate models was reviewed by the study sponsor, and six models were selected as final candidates to be evaluated in the study. The study team became familiar with the operation of each model and developed base case scenarios which were used to evaluate all the models. Each model was then evaluated against a set of qualitative criteria. When appropriate, modifications to the model were recommended. Finally, action officers were trained in use of the models.

THE STUDY SPONSOR was the Deputy Chief of Staff for Logistics, Headquarters, Department of the Army (HQDA), who established the objectives and monitored study activities.

THE STUDY EFFORT was directed by MAJ Robert G. Albrecht, Jr., Strategy and Plans Directorate.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-SP, 8120 Woodmont Avenue, Bethesda, Maryland 20814-2797.